

## Research Highlight

From May 2008 to December 2009, a suite of instruments, including a micropulse lidar, were installed at a site along Lake Taihu, China, located in the center of the Yangtze Delta region. This was part of an effort to characterize aerosols, clouds, and their interactions in heavily polluted southeastern China. The seasonal patterns and diurnal cycles of cloud fraction (CF) and cloud-base height (CBH), and the vertical structure and optical properties of cirrus clouds, were examined. Although only one year's worth of data were collected, they provide a useful first look at the characteristics of clouds, especially cirrus clouds, over this part of the world. The measurements collected also enable comparisons with similar clouds in other regions of the world.

Overall, clouds were observed 41 percent of the time over the site with a minimum in frequency in the summer (27.7 percent) and a maximum in frequency in winter (51.4 percent). This is consistent with the results reported in a study based on ground-based radar-lidar observations made from 1997 to 2002 over the Southern Great Plains site. In most months, more clouds were found at night than during the day. Concerning the presence of clouds during the day, on average, the largest CFs were observed in winter and the smallest CFs were observed in summer. At night, on average, the largest CFs were observed in spring and the smallest CFs were observed in summer.

Annual mean CBHs were  $3.05 \pm 2.73$ ,  $2.46 \pm 2.08$ , and  $3.51 \pm 3.07$  km for all clouds, daytime clouds only, and nighttime clouds only, respectively. The highest CBHs were found in spring and summer, especially during the night. The largest number of detected cloud bases fell within the range of 0.5 km to 1.0 km. The annual mean diurnal cycle of CBHs show that lower CBHs occurred around noon and higher CBHs appeared around midnight. The seasonal mean diurnal cycle of CBH was strongest in spring and summer and relatively weak in autumn and winter.

Cirrus clouds comprised #36.2 percent of nighttime cloud observations with peaks in occurrence during the summer. Cirrus base heights ranged from 7 to 14.3 km. More than 56 percent of cirrus base heights were located between 7 and 8.5 km. Cirrus top heights showed a broad (7–16 km) and multi-modal distribution, with more than 40 percent of top heights appearing in the range of 9–10.5 km. Most of the cirrus cloud cases observed had thicknesses less than 3 km. Annual mean cirrus base and top heights were  $8.89 \pm 1.65$  km and  $10.73 \pm 1.86$  km, respectively. The annual mean thickness was #  $1.83 \pm 0.91$  km. The mean lidar ratio for all cirrus cloud cases in our study was #  $25 \pm 17$  sr, with a smooth seasonal variation. No clear relation between seasonal and annual mean lidar ratio and mid-cloud height was found. Large ranges in the magnitudes of cirrus extinction coefficient (0.001–1.59 km<sup>-1</sup>) and cirrus optical depth (0.001–2.475) were observed. Approximately 12 percent of the cirrus cloud cases were sub-visible cirrus, 43 percent were thin cirrus, and 45 percent were dense cirrus. Thicker cirrus clouds occurred more frequently during the summer than in winter. Cirrus geometrical and optical properties derived in this study are similar to those reported in other studies analyzing data from lasers used to detect mid-latitude cirrus clouds.

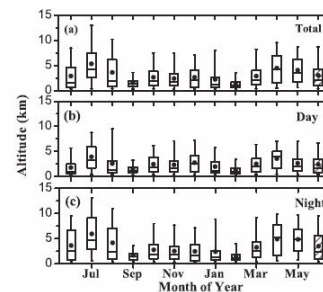
## Reference(s)

Liu J, Z Li, Y Zheng, and M Cribb. 2015. "Cloud-Base Distribution and Cirrus Properties Based on Micropulse Lidar Measurements at a Site in Southeastern China." *Advances in Atmospheric Sciences*, 32(7), doi:10.1007/s00376-014-4176-2.

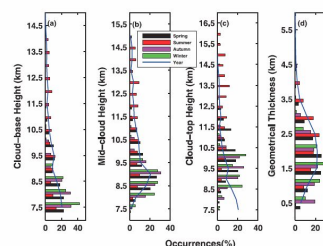
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Cloud-base heights for (a) all clouds, (b) daytime clouds, and (c) nighttime clouds over Taihu from May 2008 to June 2009. Box and whisker plots include the median (middle of the box), 25th and 75th percentiles (ends of the box), 5th and 95th percentiles (ends of the whiskers), and the mean (black dots).



Probability distributions of cirrus geometrical properties for each season (horizontal bars) and annual means (solid lines): (a) cloud-base height, (b) mid-cloud height, (c) cloud-top height, and (d) geometric thickness.

Cloud-Aerosol-Precipitation Interactions

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